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ABSTRACT

The information seeking and use habits of more than 600 scientists and engineers on staff at the European Space Agency (ESA) were studied and compared with those of staff at five European organizations with similar missions: the United Nations Education, Scientific, and Cultural Organization (UNESCO) in France; the International Atomic Energy Agency in Austria; Deutsche Forschungs und Versuchsanstalt fuer Luft und Raumfahrt (DFVLR) in West Germany; Nationaal Lucht en Raumtevaartlaboratorium (NLR) in the Netherlands; and the Centre National d'Etudes Spatiales (CNES) in France. Following an overview of the basic characteristics and traits of scientists and engineers, the report reviews the project's major findings as they relate to the type of information required by scientists and engineers: (1) its availability; (2) oral and written sources from which the information is obtained; (3) scientists' and engineers' awareness of the sources; (4) how they keep up-to-date; (5) time spent seeking the information; (6) the use made of the library or information center; and (6) patterns of communication. Twelve general suggestions are made for improving the communication and information flow within organizations to enhance the satisfaction of the information users. (SD)

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THE INFORMATION NEEDS OF SCIENTISTS AND ENGINEERS IN AEROSPACE

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A brief description of a recent research project to ascertain the communication and information-seeking and use habits of scientists and engineers working in aerospace research establishments and other organizations is given. Relevant organizations studied include DFVLR, NLR, CNES and ESA. Following an overview of the basic characteristics of scientists and engineers, a review of the project's major findings as they relate to the type of information required by scientists and engineers, its availability, the sources - both oral and written - from which the information is obtained and the scientists' and engineers' awareness of them, how they keep up-to-date, the time spent seeking information, the use made of the library and the communication patterns of scientists and engineers, is then given. Some general suggestions for improving the communication and information flow within organizations to the satisfaction of practicing scientists and engineers are made.

INTRODUCTION

The European Space Agency (ESA) is an international organization which directly handles research and development projects, unlike certain other international organizations which have a more administrative, paper-pushing or mail-box role. Because of this, it was considered useful to see how the staff of some 600 scientists and engineers at ESA's main research and development establishment - ESTEC - in The Netherlands compared with other organizations having similar roles in matters of communication and information use. A study was thus carried out to find and explain the facts surrounding the formal and informal information-seeking behaviour of scientists and engineers in a multi-national government environment. The study attempted to discover the communication channels most often used, the extent of communication with others, the nature of the communication and the use of the library or information centre in fulfilling information needs.

Fourteen organizations were approached for inclusion in the study - seven international organizations and seven national aerospace establishments. Out of the fourteen organizations invited to take part, six finally agreed to do so - three international organizations and three national aerospace establishments. The former were ESA-ESTEC, UNESCO in Paris, France and the International Atomic Energy Agency in Vienna, Austria. The latter were the Nationaal Lucht- en Raumtevaartlaboratorium (NLR) in The Netherlands, the Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt (DFVLR) in West Germany and the Centre National d'Etudes Spatiales (CNES) in France.

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The overall objective of the work, then, was to study the patterns of communication and information-seeking and use of scientists and engineers working in an international organization oriented to space research and exploration (the European Space Agency) and to see how the results compared with a) other international organizations and b) other government-oriented aerospace organizations. A better understanding of the scientific and technical information flow in such bureaucratic organizations and the reactions of staff to it, could lead to greater economies and efficiency.

Survey research was used to obtain feedback from the scientific and technical staff in these international organizations and national aerospace research establishments located in Europe on their methods of communication and their information-seeking habits. The data was gathered by means of a questionnaire consisting of mainly closed menu-type questions to save the time and effort of the respondents. A number of open questions were also included. Before being circulated the questionnaire underwent a number of pilot studies to try and achieve optimum comprehensibility and clarity. In two organizations (UNESCO and ESTEC) the questionnaires were sent directly to the individuals, while in the other four participating organizations they were sent to a focal point (the librarian) for subsequent distribution within the organization. The number of questionnaires distributed to the six organizations was 1107 of which 287 (25.93%) were finally returned after follow-up letters and phone calls. The questionnaires were analyzed by computer using the SPSS program.

DIFFERENCES BETWEEN SCIENTISTS AND ENGINEERS

Engineers are responsible for formulating basic technical concepts, transforming them from ideas into physical entities, adapting resulting products to specific applications and evaluating their usefulness. They are thus more oriented towards applications rather than the generation of new concepts and theories leading to an increase in knowledge, which is the domain of the scientist. Science is concerned with knowledge for its own sake and with the search for truth, whereas engineering is concerned with creating devices that will be useful. The engineer is thus the medium by which the public enjoys the fruits of scientific research.

While engineering on a technical level is closely related to and interdependent on science, there are distinct differences between science and engineering which must be appreciated. Engineers differ from scientists in their professional activities, their attitudes, their orientations, their academic educational process and even their typical family backgrounds, as well as in their information use and communication patterns.

The striking contrasts in communication behaviour patterns between scientists and engineers can be traced to fundamental differences in group organization and motivation. The scientist sees himself as belonging to an amorphous group of fellows who share his research interests and attitudes regardless of their organizations and geographical locations. In contrast, the engineer/technologist works for organizations

that are product/profit-oriented, which control the work (to create or improve products) and which do not permit, for competitive reasons, free communication between members engaged on propriety research and people outside the organization. Because of the nature of his work, which is not contributing to theoretical advances and an increase in general knowledge, the engineer will tend more to publish his results in internal reports and memos rather than in journals read by the scientific and technical community at large. He is thus results-oriented rather than information-oriented. As a consequence of this, the engineer is not closely connected to the formal communications media and thus has no pressing need to read journals. Technologies do have their own journal systems, like science, but the literature does not cumulate and build on itself the way science does. It contains fewer references to other work and the work reported serves to document end-products rather than announce theories.

INFORMATION NEEDS OF SCIENTISTS AND ENGINEERS

The study questionnaire asked about the requirements for facts, ideas, advice and opinions. The percentage of respondents requiring each type fairly or very often was 64% for facts, 23% for ideas, 10% for advice and 8% for opinions.

Facts were very often needed by 64% of the respondents and not very often or rarely by only 7%. Scientists needed facts only slightly less often than engineers, though in the national aerospace establishments, the number of scientists requiring facts very often was quite a bit lower than those in international organizations (54% to 64%). Among the highest users of facts were chemists (83% in international organizations and 67% in aerospace establishments), those in space technology (82% in international organizations and 61% in aerospace establishments) and those in management (72% in international organizations and 60% in aerospace establishments). A relatively low 57% said they wanted facts with any degree of urgency, with scientists in both types of organization being less bothered about the time factor than engineers.

Ideas - conceptual information - were required both very often and not very often by only one quarter of the respondents. Scientists, particularly chemists and life scientists, in aerospace establishments wanted ideas the most; while out of the engineering group those in telecommunications in international organizations were the most eager for new ideas. Conversely, just over a quarter of the latter said that they did not need ideas so often as did one quarter of those in management.

Less than 10% of the respondents wanted advice or opinions in their work - with, in fact, 40% specifically stating they did not require them at all. Engineers in international organizations were slightly more inclined to accept advice and opinions than scientists, although this position was reversed in aerospace establishments, heavily so in the case of opinions, where 12% of the scientists (predominantly life scientists) had a requirement for opinions compared to only 3% of engineers.

The respondents were asked to indicate what kinds of information required by them they could not get from the library in their organization. By far the highest type of information needed was day-to-day project-related information, next came literature, particularly from within the organization, then specific technical and experimental data.

In general, engineers required project data more than scientists, while the latter required more literature and experience. In particular, the earth scientists in aerospace establishments needed experience far more than their counterparts in international organizations. Those in space technology in both organizations required a high degree of project information, as did those in management, particularly in aerospace establishments, where over double the number of those in international organizations needed it. Interestingly enough, while chemists and life scientists appeared quite heavily involved in projects, earth scientists and physicists were not.

SOURCES OF INFORMATION

The overwhelming conclusion from an analysis of the results of the survey was that the main source for information needed on a one-time basis, on a continuing basis or for keeping up-to-date, was colleagues and the main channel was oral - i.e. personal contact. 45% of the respondents normally obtained needed information from colleagues in their own division. For information not available from the library, 58% turned to personal contacts, the originator, and contractors. To keep regularly up-to-date with what was going on in their field 39% preferred talking with colleagues at work.

The colleague or personal contact as a source of information is again emphasized by noting the other oral channels employed - 23% obtained needed information very often from colleagues working on the same project, though not in the same division; 18% got information very often from people outside the organization; 9% got information very often from other colleagues within the organization, i.e. working on a different project and in a different division; while 14% kept up-to-date by attending conferences and hence meeting people there. There was virtually no difference between scientists and engineers in the use of oral sources.

In the main, the present survey found that the source of literature used the most frequently was reports - some 30% saying they used reports very often compared to only 16% who replied they rarely used them. Nearly half the respondents rarely used books and conference papers. One third used journals very infrequently. Standards and abstract journals were also not greatly used. In most cases the engineers used every source more frequently than the scientists in international organizations, except for abstract journals. In aerospace establishments, the scientists (particularly life scientists), beside abstract journals also made greater use of textbooks, journal articles and meeting reports.

Of course, using information sources is one thing - knowing about them is another. In general, while a majority (66%) of respondents felt they were sufficiently aware of sources of information in their field, a minority (41%) felt they adequately covered them. Staff in international organizations were slightly more aware of sources than their counterparts in aerospace establishments though they covered them less. Those in non-supervisory positions tended to be more aware of their sources than those in supervisory positions and also covered them better. Scientists tended to be more aware of information sources than

engineers. 75% of all scientists (the figure rose to 83% for scientists in aerospace establishments) were aware of their sources, compared with 63% of all engineers - though engineers tended to cover them to the same extent - 42% saying they did cover them well enough, compared to 42% likewise for scientists. The latter figure was much more pronounced in aerospace establishments where 62% of scientists felt they covered them adequately compared to 33% of the scientists in international organizations.

For the vast majority of respondents non-availability of needed information from the library did not cause them any concern - they had their own sources and these were chiefly personal contacts. In fact, given a number of potential problems in getting the information needed to solve problems or complete tasks, only a handful of people said they had any difficulties. The one causing the most problems was the delay in getting hold of information - 9% said this was very often a problem.

TIME SPENT SEEKING INFORMATION

It can be inferred from the study that scientists and engineers do not keep as current as they could because a) they do not adequately cover the information sources of which they are aware and b) they do not spend sufficient time on information-seeking.

While not asking for the actual amount of time spent seeking information the questionnaire did elicit that 69% did not spend as much time as they would like on the task. People in aerospace establishments were more satisfied with the time they spent than were those in international organizations. Scientists, particularly in aerospace establishments, spent more time seeking information than engineers - though only one third of these scientists and one quarter of the engineers were satisfied they spent enough time.

Generally speaking, 56% said they did not adequately cover the sources of information in their fields - but of these no fewer than 60% read for less than two hours per week on average. Conversely, of the 41% who did feel they covered information sources adequately, 52% spent more than two hours a week on average in background reading. Overall, 54% spent two hours or less a week in background reading - more respondents in international organizations spending up to two hours than in aerospace establishments (57% compared to 48%). Scientists tended to spend a little more time than engineers in background reading - 50% reading for three hours or more compared with 43% of engineers - though a slightly higher proportion of engineers (17%) spent more than six hours a week in background reading compared to scientists (15%).

Regarding the need for facts 43% spent as long as was necessary seeking the information they needed, and 22% did not spend long at all on the task. There were no real differences between scientists and engineers, nor between the two types of organization - though non-scientists/engineers in international organizations were willing to spend the most time collecting the necessary facts.

USE MADE OF LIBRARY FACILITIES

The main reason given by the respondents for visiting the library was to scan new journals - scientists in aerospace establishments doing this more frequently. The implications here are that either journals were not circulated within the establishments or if they were, then they took so long that it was better to read them in the library before they went out on circulation. The second most popular reason for visiting the library was to borrow documents. Few went to request or carry out themselves a literature search.

It can perhaps be assumed that the average scientist or engineer used the library more to see what new books and journal issues were available rather than as a real source of information. This is borne out by the replies to a question which asked whether most of the information needed for work purposes was obtained from the library. A hefty 71% gave a resounding NO. (38% were engineers and 21% were scientists).

The kind of information which respondents required and which they could not get from the library were noted above. Briefly, they were project-related, day-to-day details, literature, technical data, administrative data and experience. Of those that replied to the question "do you feel the library should be able to supply this kind of information?" (i.e. the information they said they could not get), 59% said no and only 10% responded yes.

Undoubtedly, this is a major reason why the library is not frequented so often. 60% of the respondents visiting it less than once a week - those in aerospace establishments being the less frequent visitors. The study found that virtually half the respondents spent less than fifteen minutes in the library at any one time.

Just as those in supervisory positions visited the library less, so they also spent less time there - 53% spending less than 15 minutes there and 15% spending over thirty minutes, compared to 45% and 23% respectively of those in non-supervisory positions. In addition, 50% of those aged forty-five years and over also spent less than fifteen minutes there at any one time. Staff in aerospace establishments spent quite a lot longer time there than staff in international organizations and while engineers spent less time in the library than scientists in general, engineers in aerospace establishments spent more time there than scientists in international organizations, though not as much as scientists in their own establishments. 50% of engineers spent up to fifteen minutes in the library at a time, compared to 44% of scientists.

COMMUNICATION HABITS OF SCIENTISTS AND ENGINEERS

Staff were asked to give their communication habits over a six-month period. 50% of the respondents indicated they spent less than one third of their time communicating, while 8% spent over two-thirds.

The activities on which a majority of people spent a large amount of time were speaking on the telephone (22%) and visiting colleagues in their offices (19%) - both informal means of communicating. Among the

formal communication activities, the one most people spent most time on was in meetings with contractors. Not much time was spent in formal presentations, staff meetings, committee meetings and brain-storming sessions.

It appeared that people spent most of their time in written communication rather than oral. 16% spent at least two-thirds of their time in writing memos and telexes as well as in preparing internal reports. It was considered that staff in national aerospace research establishments would, because they were taking part in multi-national as well as national projects, have a fair degree of contact with contractors. It came as a surprise, therefore, to find that only 6% of the engineers in the aerospace establishments indicated they spent much time on contractor/consultant meetings. In international organizations the corresponding figure was 21%. For scientists the figures were much closer - 12% and 16% respectively. Similarly a higher proportion of engineers in international organizations (14%) spent over two-thirds of their time in progress meetings compared to 6% of engineers in the aerospace establishments.

It was deduced from an analysis of results that the average scientist or engineer communicated several times a day, for less than thirty minutes a time, with peers working in the same division on the same project and in the immediate vicinity. The basis for the contact was likely to be the qualifications and experience of the colleague and the initiation of the contact was done on a fifty-fifty basis. The usual nature of the contact is technical discussions for problem-solving with hard facts being the information mainly transferred. The encounter will be face-to-face in the office or laboratory of either colleague.

It was clear that people preferred to discuss matters and exchange information in a face to face mode where they could gauge the other´s facial features and movements for further feedback and clarification.

SUGGESTIONS FOR IMPROVING COMMUNICATION AND INFORMATION FLOW

With so small a sample it is obvious that the study results cannot speak for all scientists and engineers in international organizations and national aerospace establishments. Nevertheless, the results can be considered indicative of their patterns of communications and information use. The suggestions or recommendations which follow are, therefore, directed to any organization wishing to improve its communication and information flow and thus contribute to greater savings and efficiency.

Recommendation 1 :

The library should actively stimulate a much greater awareness of information within the organization

Recommendation 2 :

The library should conduct a study to ascertain actual and potential users´ real needs and requirements and information-seeking behaviour.

Recommendation 3 :

The library should aim to provide a superlative service to those who need and use its services the most.

Recommendation 4 :

Notwithstanding Recommendation 3 above, the library should aim to do more for managers, who, the survey showed, were poor library users.

Recommendation 5 :

The library should prepare, and subsequently evaluate, programmes of user education and training in information sources and use.

Recommendation 6 :

A study aimed at finding out how and why staff spend their time in the office should be undertaken.

Recommendation 7 :

The amount and flow of document preparation, copying and distribution should be measured.

Recommendation 8 :

The feasibility of installing an electronic storage and messaging system within the organization based on a local area network (LAN) should be studied.

Recommendation 9 :

Gatekeepers and boundary-spanning activities should be actively encouraged.

Recommendation 10 :

The organization should encourage and actively try to achieve a greater interaction and exchange of information between its diverse divisions and groups.

Recommendation 11 :

Management should strive to create better conditions for interpersonal communication and information use given their importance and effect in improving R&D innovation and performance.

Recommendation 12

The feasibility should be investigated of integrating under a single information resources manager the various departments dealing with information functions (such as the library; communications (mail/ telex); reproduction/printing; publications; public relations; photographic/graphics; archives; computer department).